ISSN: 1519-7859 https://doi.org/10.4322/rae.v15e202103.en

ASSOCIAÇÃO BRASILEIRA DE ERGONOMIA

Revista Ação Ergonômica

www.abergo.org.br

PRUNING AND THINNING ACTIVITIES IN GRAPE CULTIVATION: A STUDY ON OCCUPATIONAL RISKS AND THE USE OF PPE AND CLOTHING

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ABSTRACT

In this research, was performed an ergonomic analysis of the pruning and thinning work activities in the vine culture. The objective was to investigate the work conditions focusing on the occupational risks associated with the postures and movements adopted, the use of work instruments and EPI and clothing. In pruning and thinning activities, it was possible to observe an increase in the work rhythm, which may cause musculoskeletal disorders. Methodologically, the data were obtained through photographs, filming, interviews, temperature, and light measurements, as well as the survey of clothing and EPI. Results showed the need for postural corrections in both activities, distal limbs, and all other body segments due to the increased risk of injury. In addition, there is a need for change in the workplace due to the high temperature during execution. The brightness was sufficient and only the use of protection was necessary to avoid the incidence of sunlight. EPI provides the necessary protections to perform the activities. Therefore, it was possible to propose some recommendations, such as inclusion of breaks, work gymnastics, substitution of uncomfortable EPI, rotation of activities, creation of the ergonomics committee and lectures so that the corrections can be implemented properly.

KEYWORDS: Ergonomics. Pruning and thinning of grapes. EPI. Clothes.

1. INTRODUCTION

The work environment, influenced by market demands, high productivity, and intense competitiveness, can trigger various negative effects on the health of rural workers, including those engaged in viticulture.

In Northeast Brazil, grape production is concentrated in the Submédio São Francisco Valley region, in the hinterlands of Pernambuco and Bahia. Due to the abundance of natural resources and public and private investments in irrigation projects in this locality, there is a yearly expansion of cultivated areas (SILVA; COELHO, 2010).

Among the activities in viticulture are vine pruning and thinning. Vine pruning involves removing excess branches that are diseased, weak, deficient, or poorly positioned. Thinning, on the other hand, aims to loosen the grape clusters and reduce the number of berries. By removing excess berries, the remaining grapes on the cluster can develop. Approximately 60% to 70% of the berries from each cluster are eliminated (MASHIMA, 2014). In the studied area, men usually perform pruning activities, while women carry out thinning activities—a common gender division of labor in the region.

It is worth noting that both pruning and thinning activities are performed manually, requiring a significant number of workers who often operate in unfavorable conditions, adopting postures that likely cause discomfort and health problems. Additionally, unfavorable environmental conditions such as high temperatures, excessive light, air quality, and rain are prevalent.

The postures adopted during pruning and thinning activities can lead workers to experience Repetitive Strain Injuries and Musculoskeletal Disorders (RSI/MSD). Therefore, there was a need to study these postures, movements, and their impact on the health of the involved workers. Couto (2007) states that shoulder movements allow for a high number of posture changes, but exaggerated movements performed few times during the workday can lead to muscle overload.

However, analyzing and correcting inappropriate postures within a company can be challenging. Evaluations are typically conducted through interviews with employees, and corrective measures, such as occupational gymnastics, tool adjustments, and breaks, are often implemented late, after the injury has already occurred (LOPES et al., 2013).

In agriculture, particularly in viticulture, an exploratory survey identified some complaints of pain possibly related to the postures adopted during pruning and thinning activities. This prompted the need for a more in-depth study of the relationships between workers' activities and physical and biomechanical risks.

In addition to postural problems, other elements such as environmental factors (e.g., temperature, ventilation, and lighting) can influence workers' activities and their relationship with protective measures. This, in turn, depends on the good fit of Personal Protective Equipment (PPE) and clothing.

It is important to highlight that rural companies have incorporated the use of Personal Protective Equipment (PPE). Some do so considering it an essential part of the process, while others do it to comply with regulatory standards aimed at eliminating or reducing risks and enhancing the safety and health of workers, especially during the handling of chemicals. However, there are reports of fit issues during use that can compromise the level of protection provided by this equipment. For example, Garrigou et al. (2010) found, in a study with rice cultivation workers, that PPE did not provide the necessary protection, making workers

susceptible to contamination due to the equipment's ineffectiveness. It was also observed that rural workers were contaminated when putting on, taking off, or even washing PPE. Therefore, studying the fit of such equipment during pruning and thinning activities is relevant to this study.

According to Alves (2016), fit refers to the extent to which clothing or any other artifact can be worn and used by a specific group of users to achieve specific objectives effectively, efficiently, and satisfactorily in a given context. The study of clothing and PPE also involves the issue of thermal comfort since excessive sun exposure and discomfort from equipment can contribute to non-use by workers.

In addition to PPE, work clothing used in viticulture, mainly consisting of long pants and a blouse, needs to be investigated, particularly for its protective function. This is compounded by the fact that there are few studies in this context on the relationship between occupational risks and the use of PPE and clothing.

Therefore, this article presents proposals for measures to increase the safety of rural workers, based on the investigation of working conditions in pruning and thinning activities in grape cultivation, focusing on physical, biomechanical, and environmental occupational risks and their relationships with the use of tools, PPE, and clothing.

2. THEORETICAL FRAMEWORK

2.1. VITICULTURE SECTOR AND ERGONOMICS

The viticulture sector presents a significant demand for ergonomic actions, especially regarding pruning and thinning activities, considering the limited research on the impact of these activities on the well-being of workers (TORRES; PINHEIRO, 2009). Some easily observable characteristics contribute to this opinion: the posture to which workers submit themselves to perform the activity, the time spent on the activity, and the tools used. It is noteworthy that all these factors are related to the field of ergonomics.

According to Wisner (1994), ergonomics applied to the workplace improves the quality of activities and contributes to employee satisfaction and well-being, also reducing costs related to occupational diseases. The application of ergonomics results in benefits for the employer and the company, particularly in terms of increased safety, preserving physical and mental integrity. Consequently, employee performance is likely to improve, leading to a reduction in absenteeism.

In the grapevine sector, the need for ergonomic studies is also high, especially in pruning and thinning activities, which are carried out using manual methods. Additionally, these activities involve a large workforce operating in open fields, exposed to unfavorable weather conditions, and performing tasks with high physical demands while standing throughout the workday.

2.2. IMPORTANCE OF VITICULTURE IN THE SUBMIDDLE OF SÃO FRANCISCO

The Submiddle of São Francisco is located in the Brazilian Semi-Arid region, comprising cities in the states of Pernambuco and Bahia. It is characterized by a dry and hot climate (PEEL; FINLAYSON; MCMAHON, 2007), with low rainfall and long periods of drought (LIMA et al., 2009). The various favorable conditions that promote high productivity, combined with the presence of the São Francisco River in a Semi-Arid region, have attracted government incentives, making the region nationally and internationally prominent in irrigated fruit farming, with a primary focus on grapes and mangoes.

In recent decades, this locality has established itself as the country's main producer of table grapes. The region specializes in the cultivation of seedless grapes, accounting for 95% of exports (MENDES, 2012). Seedless table grapes from the region have significantly increased demand in both domestic and international markets. The latter, in particular, has a preference for seedless grapes (PROTAS; CAMARGO, 2011). To achieve high-quality fruits, specific cultural practices are required, such as pruning and thinning.

2.3. THINNING AND PRUNING

In the thinning stage, using thinning shears, berries measuring 3–6 mm to 7–10 mm in diameter, known as 'pea-sized,' are removed. Small, defective, and excess berries are taken out. Subsequently, several passes are made as differences in berry size become more visible (NACHTIGAL, 2005). In thinning activities, fingers are usually employed. However, in extreme cases where thinning is delayed, berries can become too large, necessitating the use of shears.

Pruning involves a set of operations performed on the plant, consisting of removing the woody (trunk) or herbaceous (shoots or leaves) vegetative system. There are four types of vine pruning: establishment, training, fruiting, and renewal, performed based on the vine's age (MANDELLI et al., 2003).

The execution of pruning and thinning activities can potentially lead to health problems when improper postures are adopted. There are reports of upper limb pains such as back, neck, shoulders, arms, wrists, and hands; lower limb pains such as legs, ankles, and feet. Coupled with sun exposure, which can cause vision and skin problems. In this scenario, knowledge generated by ergonomic studies plays a crucial role in adapting the work environment, eliminating or reducing risks related to posture and the physical work environment, among other factors.

In Brazil, Regulatory Norm No. 17 (NR 17), despite being considered incomplete by some researchers, represents a significant advancement in applying ergonomic principles (SILVA, 2016). NR 17 establishes parameters for the psychophysiological adaptation of the work environment to the worker, addressing furniture, equipment, environmental conditions of the workstation, and the organization of work itself, aiming to provide comfort, safety, well-being, and better performance of activities within this context (BRAZIL, 2017).

It is worth noting that NR 17 does not cover activities in outdoor environments; instead, it regulates activities carried out in the field. It aims to reconcile the planning and development of activities in agriculture, livestock, forestry, logging, and aquaculture with safety, health, and the work environment (BRAZIL, 2013).

All the mentioned variables can be assessed through the application of methods and tools, such as the Ergonomic Work Analysis method (AET) and Moore & Garg and Reba tools

2.4. ERGONOMIC WORK ANALYSIS (AET)

For the evaluation of the workstations of thinning workers and pruners, the Ergonomic Work Analysis (AET) methodology developed by Jacques Duraffourg in 1977 was employed. This methodology is divided into demand analysis, task analysis, activity analysis, diagnosis, and ergonomic recommendations. Despite AET being commonly used for technical intervention, in this study, it was employed as a guide for data collection and analysis.

2.4.1. DEMAND ANALYSIS

Demand analysis is the description of a problematic situation that justifies the need for an ergonomic action, or in this case, a scientific investigation. It can have various origins, both from the company management and from the workers and their union organizations. Demand analysis seeks to understand the nature and extent of the issues presented (IIDA and BUARQUE, 2016).

2.4.2. TASK ANALYSIS

In the task analysis phase, differences between what is prescribed and the activity performed by the worker are assessed. This difference can occur due to various factors involved in the activity, as the actual conditions may differ from those anticipated in the execution. Moreover, workers may not always correctly follow what is described. Therefore, the analysis should not be based solely on the requested task (IIDA and BUARQUE, 2016).

2.4.3. ACTIVITY ANALYSIS

In this stage, the activities carried out by the workers are studied, evaluating the work and not the worker, seeking to understand the relationship between the worker, the task, and the means to accomplish it

2.4.4. DIAGNOSIS

Based on the data obtained in the previous stages, a diagnosis should be generated. According to Iida and Buarque (2016), the diagnosis identifies the causes that lead to the problem described in the demand, encompassing various factors related to work and the company.

2.4.5. RECOMMENDATIONS

Recommendations pertain to the measures that should be taken to address the diagnosed problem. These recommendations should be clearly specified, describing all the necessary steps to resolve the issue (IIDA; BUARQUE, 2016).

3. METHODOLOGY

An exploratory and descriptive qualitative field research was conducted, as the variables studied for the characterization of thinning and pruning processes, working conditions, as well as personal protective equipment (PPE) and clothing worn by workers, were mostly described based on the perceptions of both the interviewees and the interviewer.

The field study took place on a farm in the Submiddle São Francisco Valley, focusing on the export of table grapes, located in Santana do Sobrado, Casa Nova municipality (BA), approximately 50 km from Petrolina (PE).

Data collection began after approval by the Research Ethics Committee of the Federal University of Pernambuco, granted on 14/03/2019, under opinion no. 3,197,883. The research involved 20 pruners and 45 thinning workers, all of whom signed the Informed Consent Form.

3.1. STAGES AND PROCEDURES FOR DATA COLLECTION

- Stage 1: Survey of employees on sick leave and medical certificates related to complaints of musculoskeletal pain over a 3-year period;
- Stage 2: Documentary analysis of the work prescribed by the company;
- Stage 3: Direct observations, video recording, and image capture of pruners and thinning workers performing their work activities using a Canon PowerShot SX520HS digital camera and a Poker Pro Running Digital stopwatch to determine the work cycle. Subsequently, posture analyses were conducted. For the analysis of the risk of wrist and hand injuries, the Moore & Garg Index was applied, and for whole-body assessment, the REBA tool was used. These tools help identify postural overload and

indicate the severity level for possible injuries. The tools were used within the Ergolândia software.

- Stage 4: Application of the Corlett diagram;
- Stage 5: Interviews mediated by a questionnaire were conducted to assess the wearability of PPE and clothing and their relationship with occupational risks. The effectiveness and satisfaction components were evaluated, followed by content analysis with quantification of frequency and percentage;
- Stage 6: Application of a sociodemographic questionnaire to characterize the profile of the interviewees;
- Stage 7: To measure the ambient temperature, a globe thermometer was used—positioned between the vine rows with the globe at a height of 1.50 m for a period of 3 hours between 11 am and 2 pm, following the recommendations of the Occupational Hygiene Standard (NHO 6) of Fundacentro. For evaluation, the formula for outdoor environments with solar load was used: IBUTG = 0.7tbn + 0.2tbs + 0.1tg, where tbn is the natural or wet bulb temperature; tbs is the dry bulb temperature; tg is the globe temperature;
- Stage 8: To measure the ambient light, a luxmeter was used. Readings were taken throughout the day, between 11 am and 2 pm. The luxmeter was positioned at eye level, where various activities take place, and the reading was obtained in lux, following the Occupational Hygiene Standards (NHO 11) of Fundacentro. For evaluation, the NBR ISO/CIE 8995-1 standard was used as a parameter

4. Results And Discussion

4.1. Profile Of Research Subjects

The pruning workers had an average age of 35.5 years (24 to 48). Thinning workers had an average age of 40.6 years (24 to 55). Regarding education, the majority of pruners (75%) and thinning workers (49%) had incomplete primary education. According to the farm's agronomist, educational attainment is not a prerequisite during the hiring process, but experience in pruning and thinning is required.

4.2. Analysis Of Ergonomic Demand

After several visits and informal conversations with the involved workers and the farm's health department, it was identified that the work schedule, combined with postures performed without proper guidance and the absence of breaks during task execution, could lead to musculoskeletal injuries. Environmental factors such as temperature and lighting could also influence the development of activities. Personal Protective Equipment (PPE) and clothing were assessed, particularly their effectiveness during task execution.

4.3. Task Analysis

The work routine of thinning workers and pruners begins with their arrival at the farm, around 06:40, followed by a gathering for timekeeping at 07:00. After this, they take a bus to the specific work location. The total workday comprises 9 hours, amounting to 45 hours per week. Activities are carried out without shorter breaks; there is only a one-hour break for lunch and rest.

Pruners start their activities after receiving instructions from the supervisor, using pruning shears as their main tool. With the pruning shears in their right hand, they cut the branch, while with the left hand, they remove the branch, letting it fall to the ground (Figure 1). Their

task involves removing all the foliage along with the branches so that the plant can recover and start producing again.

Figure 1 - Pruning of the grapevine, cutting and removal of the branch.

Thinning workers use a metal bench to improve their reach to the grape cluster. However, this bench usually does not provide adequate access because it lacks an adjustment mechanism to adapt to the different heights of each thinning worker. The workers start the thinning activity using their hands without the aid of additional tools. They perform small twists with the left hand to facilitate the visualization of the cluster, while using the fingers of the right hand in a pincer-like motion to remove damaged or uneven berries (Figure 2).

Figure 2 - Thinning of the grapevine carried out by hand.

4.4. ACTIVITY ANALYSIS

In this stage, the activities performed by pruning and thinning workers were observed, including their postures, the use of Personal Protective Equipment (PPE), clothing, and their relationship with the company's prescription.

4.4.1. PHYSICAL AND GESTURAL CONSTRAINTS

It was identified that during the execution of activities, pruners alternate the position of the upper limbs. The right arm remains mostly above the shoulder line while cutting branches, while the left arm alternates its position above when removing the branch and below the shoulder line when depositing the branch on the ground (Figure 3)

Figure 3 - Posture during pruning.

According to Dul and Weedmeester (1995), working with the arms above the shoulder line can be detrimental to the health of workers. In the impossibility of keeping the arms below the shoulder line, such activity should be executed for a limited time.

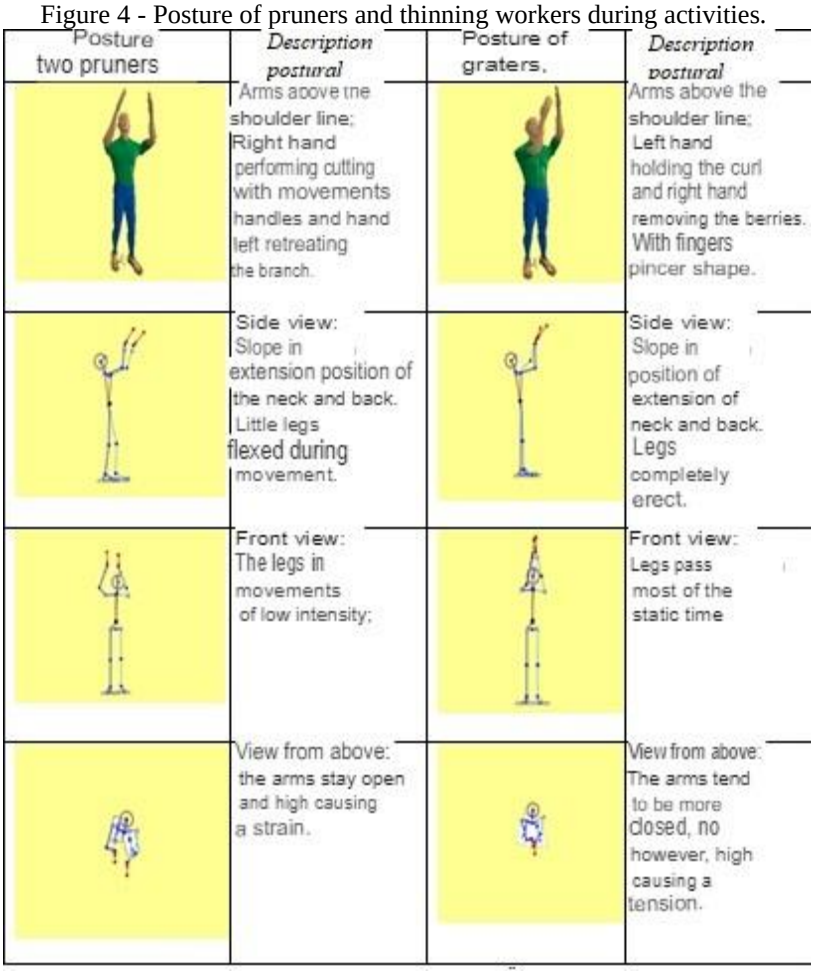
Pruners also perform repetitive movements with the right hand during the cutting of branches

with the pruning shears. The back remains mostly with a slight inclination, while the neck tilts backward due to the need to observe the branch during cutting. The activity is dynamic with low-intensity movements of the lower limbs. Most of the time, there is little knee flexion, which occurs only during movement.

Thinning workers carry out their activities in a static position without movements of the lower limbs. They remain in an upright position throughout the workday, which can lead to circulation problems. Dul (2012) states that it is not appropriate to spend the entire workday standing. Such a posture can cause fatigue in various regions of the body, such as legs and back.

However, in some activities, the standing position is recommended because the spine is correctly aligned, exerting less pressure on the intervertebral disc. The arms remain above the shoulder line throughout the activity, performing repetitive movements of the distal limbs, specifically the fingers during berry removal. There is a backward tilt in the back and head for the visualization of the grape cluster (Figure 4).

Figure 4 - Posture of pruners and thinning workers during activities.



Source: SSPP Software version 7.0.5.

For Martins (2001), no posture is good enough to be maintained comfortably for long periods. However good the posture is, it can bring static overload on the muscles and, as a result, lead to discomfort.

Therefore, it was possible to infer that there is a need for intervention regarding postural improvement, especially because the company does not yet have an ergonomic intervention policy, nor the necessary knowledge for short-term adjustment.

4.4.2. Analysis Of Data From The Map Of Painful Areas

The data obtained regarding the occurrence of pain in pruning workers reinforced the need for postural interventions. In other words, the body segments with the most frequent complaints were the neck (80%), arms (65%), and shoulders (55%), followed by forearms, wrists, and hands, and finally, the back. Despite the upper limbs showing the highest percentages of pain, the lower limbs - legs (20%) and thighs (20%) also showed a relevant occurrence of pain.

Among the thinning workers, discomfort complaints also concentrated on the upper part of the body - neck (93.3%), arms (88.8%), and shoulders (86.6%). Next were the forearms, back, hands, and wrists (33.3%). In the lower limbs, ankles and feet were the most cited, followed by legs and thighs.

During the workday in pruning and thinning, there is a high demand on the distal upper limbs with a predominance of repetitive movements. Consequently, this could lead to injuries.

4.4.3. Risk Of Injuries To Upper And Lower Limbs

In pruning, the worker, with the right hand armed with pruning shears, makes the cut of the branch, and with the left hand, performs the removal of the freshly cut branch. During this process, a pronounced curvature in the cervical spine and neck of the pruners can be observed (Figure 5). The legs also vary in position: sometimes the body weight is distributed on both legs, sometimes it is distributed on one leg. The right arm remains constantly above the shoulder line, and the left arm alternates between the line above the shoulders and below when the branch is left on the ground.

Figure 5 - Sequence of posture in the pruning activity.

The body segments of Group A, composed of the trunk, neck, and legs, and Group B, composed of the arm, forearm, and wrist, were evaluated. In the pruning assessments, two types of postures were considered due to the inherent dynamism of the activity - with fast and repetitive movements.

Position A posture presented: neck and trunk in extension, legs with unilateral weight support; arms above 90° degrees; forearm above 100° degrees; wrists with mobility of 15° degrees up and down; grip considered reasonable; load less than 5 kg. In position B, it was observed that: neck and trunk varied between 0° and 20°; weight support on both legs; arms alternating

between 45° to 90°. Forearm above 100° degrees; wrists with mobility of 15° degrees up and down; grip considered reasonable; load less than 5 kg.

In the pruning analysis, optional elements such as neck, trunk, load, and activities (repetitive movements and large postural changes or unstable posture) were added. This was necessary to closely approximate the posture assumed by the workers.

Table 1 describes the results of the risks related to positions A and B adopted during the pruning activity. In position A, a score of 11 indicates a very high risk of injury. Therefore, immediate changes should be implemented for this position. In position B, a score of 8 indicates a high risk of injury, so an investigation and subsequent implementation of changes are necessary (Table 1).

In the evaluation using the REBA tool, it was identified that in both positions (A and B), there is a need for ergonomic intervention in all postures assumed during the task

Table 1 - Postural analysis during pruning activity.

Position	Neck	Trunk	Legs	Arm	Forearm
(A)	Extension	Extension	Support on one leg	> 90°	> 100°
(B)	0 a 20°	0 a 20°	Support on both legs	45° e 90°	> 100°
(A)	Between 15°	Reasonable	Less than 5 kg	11	Very High
(B)	Between 15°	Reasonable	Less than 5 kg	8	High

Source: Data analyzed in the Ergolândia software.

The grape thinners perform their activities always in a standing position, alternating the body weight between both legs or only on one; the arms are always above the shoulder line throughout the task cycle; the cervical spine and the neck alternate between the upright position and the extended position with trunk and neck twisting; the left hand holds the bunch of grapes, and the right hand removes the berries (Figure 6).

Figure 6 - Sequence of postures in thinning activity.

For the application of the REBA tool in the activities of thinning, the same body segments described in pruning activities were considered: group A, involving the trunk, neck, and legs, and group B, including the arm, forearm, and wrist. Two postures were evaluated during the thinning task. In position A: neck and trunk in extension; unilateral leg support; arms above shoulder level - greater than 90° degrees; forearm above 100° degrees; wrists with an angle up to 15°; reasonable grip; load less than 5 kg.

Posture B differs from the previous position because the neck and shoulders remained at an angle between 0° and 20° degrees, and the body weight supported with bilateral distribution on both legs. Arms between 45° and 90° degrees, forearms above 100° degrees, reasonable grip, and a load less than 5 kg. In optional aspects, additional considerations for the posture included the neck rotating to the right or left and tilting to the side, and the trunk rotating to the right or left with a tilt to the left or right. Regarding activities, it was considered if one or more parts of the body were maintained for more than 1 minute and repetitive movements with more than 4 movements per minute.

In the interpretation of the data presented in Table 2, positions A and B obtained the same score (9), indicating a high risk of injury due to improper posture. Therefore, it is necessary to investigate all interfering factors, followed by the implementation of changes. In thinning tasks, intervention is crucial to prevent musculoskeletal injuries or other health problems such as RSI/WRULD.

Table 2 - Application of the REBA tool for the thinning task.

Position	Neck	Trunk	Legs	Arm	Forearm
(A)	Extension	Extension	Support on one leg	> 90°	> 100°
(B)	0 a 20°	0 a 20°	Support on both legs	> 90°	> 100°
Position	Wrist	Grip	Load	Score	Risk
(A)	Between 15°	Reasonable	Less than 5 kg	9	High
(B)	Between 15°°	Reasonable	Less than 5 kg	9	High

Source: Adaptation by the author from the Ergolândia software.

4.4.4. Risk Of Injuries In Distal Limbs

In pruning activity, it was identified that the cycle of the activity lasts an average of 6 to 8 minutes, the time needed to complete one plant. The cycle starts when the worker begins pruning one plant and is completed after its conclusion. With the right hand, 320 cuts are made with the pruning shears, while the left hand removes branches approximately 290 times, thus completing the cycle. The duration of the daily work shift is 9 hours.

After applying the Moore & Garg tool, the final RULA score obtained was 54, which is above the threshold of 7. Therefore, the activity poses a serious risk of injury to the distal limbs - hands and wrists, requiring immediate intervention. The evaluations of both hands were conducted separately in the research because each hand performed a different activity during the task cycle. However, the results were the same.

In the pruning activity, the worker uses pruning shears in the right hand (right-handed) and removes the branch with the left hand. The branches are often entangled, requiring force for their removal. The frequency is quite high, with an average of 62 cuts per minute. In addition to the high frequency, the wrists undergo twisting movements, which may lead to wrist or hand injuries, according to Moore & Garg. In the thinning activity, both hands perform the

same activity. Therefore, only one evaluation was necessary. Twenty clusters were monitored to determine the cycle time. Thinning each cluster took an average of 11 seconds. After starting the thinning of the cluster, the cycle begins and is completed when the thinning tool picks up another cluster. Ten efforts were made during the cycle (squeezing the shears to cut the berries). It is concluded that the result of the multiplication of factors was below the values of pruning, with a RULA score of 27. However, the obtained value was quite high, indicating a high risk, requiring immediate ergonomic intervention.

In the thinning activity, the interviewees complained of pain in the wrists and hands, which is confirmed by the result of Moore & Garg, indicating a need for ergonomic intervention due to the risk of injuries to the distal limbs. The improper position of the wrists and fingers (pinching) throughout the work shift can result in injuries. This occurs due to the repetitiveness associated with the frequency of execution. Therefore, a change should be made to minimize the high risk of injury.

4.5. Environmental Factors

4.5.1. Analysis Of Thermal Overload

This evaluation aimed to assess the environmental conditions of thermal comfort during pruning and thinning tasks, considering that excessive heat exposure can lead to thermal overload in workers. Assessments were conducted on May 29, 2019, between 11 am and 2 pm, considering this period as the most unfavorable for the activity's development.

The activity is considered continuous, and the tolerance limit used in this study was 26.7°C (moderate) for pruning and thinning, following NR 15 insalubrity regulations. In pruning, the average Wet Bulb Globe Temperature Index (WBGT) value for a "moderate" activity was 34.50 °C, while in thinning, the average WBGT value for a "moderate" activity was 28.30°C (Table 1). Therefore, the obtained values exceeded the limit allowed by NR 15, classifying both activities as unhealthy. The working environment for pruning was well above the permissible limit, potentially posing health problems for the involved workers.

Table 1 - WBGT Values Found in Pruning and Thinning.

Activity	Found WBGT
Pruning activity	34,50°C
Thinning activity	28,30°C
Maximum Allowable	26,7° C

Fonte: Pesquisa do autor.

4.5.2. Luminosity Analysis

For the evaluation of natural illuminance in outdoor areas, there are no standards that serve as parameters. The ABNT NBR ISO/CIE 8995-1 (2013) standard provides parameters for both indoor and outdoor environments, considering artificial illuminance such as lamps and poles for the latter.

In the studied location, illuminance varied according to the characteristics of the two workstations. Assessments took place between 11 am and 2 pm on May 29, 2019, with 10 evaluations conducted. Subsequently, the average illuminance for each workstation was obtained: 82,771 lux in pruning and 5,327 lux in thinning. The illumination at the site is quite high, necessitating the use of protection to avoid direct eye contact with the ultraviolet radiation emitted by the sun.

4.6. Fit Of Ppe (Personal Protective Equipment)

During both activities - pruning and thinning - safety glasses, cotton gloves, caps, and protective boots are the main PPE (Personal Protective Equipment) used by the interviewed workers. The cap serves the purpose of protecting against solar radiation for the majority of pruners (75%) and against solar and physical radiation for 25% of them. Similarly, among thinners, the Arab cap provides solar protection (80%) and solar and physical protection (20%). In other words, respondents recognize the importance of wearing caps during work activities, and this use is highly satisfactory, according to 100% of pruners and 96% of thinners.

For 80% of pruners, gloves serve to protect against solar radiation, while for the remaining 20%, they have functions of physical, solar, and insect bite protection. For thinners, gloves function for solar protection (71%) and physical, solar, and insect protection (29%). Regarding satisfaction, all pruners said they are satisfied with cotton gloves, meaning there were no reports of discomfort. In thinning, 87% of respondents find the gloves comfortable, and 13% find them uncomfortable.

Glasses serve to protect the eyes from particle projection and exposure to environmental factors such as sun, rain, and dust. For pruners, glasses function for physical protection (55%) and physical and solar protection (45%). Similarly, according to thinners, glasses serve for physical protection (84%) and physical and solar protection (16%). This confirms among respondents the perception of the importance of using this PPE. However, the majority of pruners (55%) and thinners (62%) consider glasses uncomfortable. Respondents from both activities reported that glasses cause headaches, dizziness, and often fog up on colder days. In addition, the lenses are commonly scratched during handling, impairing good visibility. These discomforts may be caused by the material of the glasses (plastic) and the presence of prescription lenses. According to the interviewees, the prescription lenses can cause dizziness and headaches.

Another essential PPE in agriculture is boots, mainly because there is a risk of accidents with insects or venomous animals in the work environment of this group of workers. Among pruning workers, boots serve for physical protection (55%) or physical protection and against insects (45%). For female thinners, boots provide physical and insect protection (60%) or physical protection (40%). The use of boots was considered comfortable by the majority of pruners (75%) and uncomfortable by most thinners (62%). There were reports of thermal and physical discomfort with the formation of calluses, as well as the proliferation of fungi on the nails. Probably, boots cause thermal discomfort due to the negative interaction between the body, the boot material, and the high temperatures of the studied region. This leads some female workers to replace the boots provided by the company. This was reported by five female thinners who, during the research, were wearing boots they had acquired themselves in an attempt to minimize discomfort.

In summary, most employees experience some discomfort while using PPE. Additionally, the lack of an appropriate place to store these PPEs on the farm often results in non-use due to employees forgetting their PPE at home. Conversely, in these cases, there is also resistance from safety technicians to providing new PPE. Regarding the non-use of PPE, Bezerra et al. (2012) stated that many farmers do not have the habit of using PPE, especially for long periods. This increases exposure to risks. Possibly, the lack of training on the use of PPE contributes to worsening this situation, despite the majority of respondents (95% of thinners and 55% of pruners) reporting that they have undergone training on the use of PPE.

4.7. Clothing Assessment

Human beings spend about a third of their lives working. Therefore, several factors influence their productivity (MOURA and XAVIER, 2010). Among them is the limited wearability of

clothes used in the work context.

Regarding wearability, the metrics of the "effectiveness" component provide data on how well the clothing has achieved its function in a given context, and the metrics of the "satisfaction" component indicate how much the user is free from discomfort and their positive attitudes toward the clothing worn (ALVES and MARTINS, 2017). According to Alves (2016), comfort is related to the configurative characteristics of clothing, resulting from the combination of tailoring and the material used in its manufacture.

In this perspective, during data collection, there was an attempt to identify the composition of the clothing used by the respondents. However, this characterization proved unfeasible because they have the habit of wearing worn-out clothes to work. Therefore, most clothes did not have composition labels, or the labels were deteriorated.

Another relevant factor was the identification of parameters used by workers in choosing the clothing for work activities. It was observed that pruning workers usually wear long pants, often made of polyester or jeans, and long-sleeved shirts made of polyester or cotton (Figure 7).

Figure 7 - Workwear of the pruners.

The thinning shears users wear polyester clothing - long pants, sometimes skirts or dresses over leggings, long-sleeved shirt, and a jacket for increased protection (Figure 8).

Figure 8 - Workwear of the thinning shears users.

The majority of pruners (60%) reported not having a preference for a specific type of clothing. Conversely, the majority of thinning shears users (56%) confirmed having a preference. However, the interviewees reported three main parameters for selecting work clothes: 1) lightweight or less warm clothes – pruners (55%) and thinning shears users (60%); 2) thick clothes – pruners (10%) and thinning shears users (9%); 3) any type of clothing – pruners (35%) and thinning shears users (31%). The use of synthetic cool mesh fabrics was also common due to the perceived sensation of coolness and cotton knit fabrics. However, considering the high temperatures of the studied environment, synthetic fiber clothing may possibly cause greater thermal discomfort due to increased temperature compared to cotton garments.

It was also observed that the majority of pruning and thinning employees use cloths covering their entire face to increase protection against sunlight and projection of plant particles on the face. In pruning, 70% of the respondents said they use the cloth covering their face for sun protection, and 30% said they use it for both sun and physical protection. In thinning, 93% said that the cloth covering the face serves for sun protection, and only 7% said it serves for both sun and physical protection.

Pruning and thinning employees are exposed to factors related to thermal stress since the activities are carried out in open environments with temperatures that can reach 38°C, depending on the season. According to Moura and Xavier (2010), heat dissipation requires the ambient temperature to be below 34°C, as this is the natural temperature of the skin. Therefore, clothing is an important factor for proper heat dissipation.

4.8. Discussion Of The Diagnoses

According to the data obtained through the ergonomic analysis of work, various factors contributing to risk conditions in the investigated work context can be identified, such as the emergence and aggravation of musculoskeletal problems resulting from the work postures adopted for pruning and thinning activities.

In pruning, everyone performs activities in a standing position with low-intensity movements in the lower limbs. However, the upper limbs perform activities with moderate movements, alternating positions above or below the shoulders, and the hands make an average of 62 cuts per minute on the branches.

Thinning shears users perform their activities in a standing position with virtually no movements in the lower limbs. The arms are consistently above shoulder height due to the need to stay in contact with grape clusters. Consequently, they spend most of the activity with extended arms, and the neck and back are often in an extended position. Additionally, wrists and hands perform repetitive movements exhaustively, and fingers make pinching movements to remove berries an average of 10 times per minute.

The extension of the upper limbs without proper support requires the involved muscle groups to remain under tension, leading to static effort that constitutes a state of muscle contraction (ABRAHÃO et al., 2009).

The work rhythm is exhausting, generating repetitive stress on the upper limbs, with emphasis on the distal limbs - wrists and hands. The posture is inadequate, as mentioned earlier. The absence of breaks in both activities enhances the risks of occupational diseases, favoring the emergence or worsening of musculoskeletal disorders.

In the workplaces, it is also not possible to alternate between standing and sitting positions. As a result, the entire workday is performed standing. It is worth noting that repetitive, static, or even dynamic efforts for an extended period can result in microtraumas, causing injuries to joints, tendons, or ligaments (KROEMER; GRANDJEAN, 2005).

The metal benches aim to elevate thinning shears users, facilitating access to grape clusters. However, some benches lack adjustment based on anthropometry, making it difficult to adapt to each employee's height and thus contributing to improper posture.

Regarding Personal Protective Equipment (PPE), it can be inferred that workers understand their function and importance for protection against occupational risks, but most of them were assessed as uncomfortable. For example, glasses were associated with headaches and fogging on cloudy days; pigmented gloves provide protection in both activities, although for pruning, leather gloves would be ideal, offering greater protection against mechanical or cutting agents; boots often become quite warm due to ambient temperature and can cause calluses or nail loss.

The ambient temperature exceeded the thermal comfort defined by NR17, reaching 26.7°C. Nevertheless, this value is below the region's average, as the data collection period coincided with the coldest months of the year, from April to July. The temperature tends to rise from August and September onwards.

Workwear is not suitable, as it does not provide the necessary thermal protection, considering that the choice is not based on the real need for protection. For instance, the use of polyester clothing may increase physical and thermal discomfort. Additionally, wearing multiple layers of clothing, such as shirts and jackets, can further impede sweating and, consequently, increase fatigue and dehydration.

4.9. ERGONOMIC RECOMMENDATIONS

Based on the results obtained, here are some recommendations aimed at improving the quality of life in the workplace, focusing on the comfort and well-being of individuals involved in pruning and thinning activities in the grapevine culture.

- Initially, establish an ergonomics committee similar to the CIPA, with monthly meetings aimed at investigating and monitoring working conditions related to environmental factors, in order to discuss and suggest improvements.
- Implement a practice of spine stretches to reduce tension, improve body performance, and compensate for the structures of the body most used during work, while avoiding those that are not required, relaxing and toning. Perform hand stretches at short intervals during the workday to reduce injuries to the distal limbs.
- Workers in both activities should alternate roles, working in two areas with different characteristics, alternating between thinning in an open area and the packing house in a closed area, considering different postural characteristics.
- Introduce 10-minute breaks for every hour worked to reduce risks associated with repetitive efforts and consequently decrease fatigue.
- Establish a clinical recovery monitoring program for workers affected by RSI/WRULD.
- Conduct lectures for all pruning and thinning employees to inform them about occupational risks.
- Replace boots with a more comfortable model, such as polyester-lined fabric with rapid sweat absorption and desorption, allowing breathability and maintaining foot temperature.
- Regarding glasses, replace them with a model that does not fog up.
- Develop pamphlets, educational booklets, and short videos that can be presented in training sessions and shared via WhatsApp among workers.
- Implement the use of uniforms for effective protection against ultraviolet rays and materials that facilitate heat exchange between the skin and the environment to increase user satisfaction.

5. CONCLUSION

This study investigated the working conditions in pruning and thinning activities in grapevine cultivation, focusing on occupational risks associated with postures and movements adopted, the use of tools, personal protective equipment (PPE), and clothing. It also proposed recommendations aimed at increasing the safety of rural workers.

The starting point was the assessments guided by the methodology of Ergonomic Work Analysis to identify demands and provide insights for future interventions. The results obtained in both activities after applying auxiliary tools generally indicate the need for changes in the postures adopted by pruners and thinners, which may lead to repetitive strain injuries and musculoskeletal disorders.

Based on the questionnaires identifying painful areas, it can be concluded that the neck, shoulders, and arms are the areas with the highest discomfort complaints, according to the interviewed workers in pruning and thinning. This was evident in field assessments, as all involved workers remain standing throughout the workday, with their arms above shoulder height, specifically during thinning.

Regarding environmental heat assessments, it is concluded that the results in both activities exceed the tolerance limit, making the environment unhealthy, leading to discomfort, sunstroke, cramps, fatigue, and, in extreme situations, exhaustion. It is the responsibility of the company to educate its employees about the health risks associated with sun exposure.

The illuminance in the workplace is natural and high. For the activities, the use of glasses is necessary. However, according to the literature, ultraviolet rays can cause cancer or injuries to the cornea or lens and may cause glare when the neck is in an extended position.

Regarding PPE, the necessary protections are provided for the safety of workers in both evaluated activities. However, dissatisfaction is reported with the use of glasses and boots.

Employees use their personal clothing. According to the research, most prefer lighter clothes, as they facilitate the sweating process. In pruning, workers state a preference for lighter clothes, while a minority prefers thicker clothes. In thinning, the majority of workers prefer lighter clothes, and the minority prefers thicker clothes. However, ideally, work uniforms adapted to the activities would be more suitable.

It is expected that the results of this research contribute to the improvement of the quality of activities performed by workers in pruning and thinning, as well as the comfort and safety of this group of workers. The aim is to raise awareness among managers about the need for ergonomic intervention in agriculture to increase productivity and reduce occupational risks.

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